

ORIGINAL RESEARCH

A Primary Care Intervention to Improve Melanoma Detection and Management

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Background: The incidence of cutaneous melanoma is increasing while access to dermatology care remains limited. Primary care clinicians are poised to identify and triage melanomas. However, barriers exist, including clinician knowledge and confidence. We tested the feasibility of an educational intervention to improve melanoma identification and management in primary care.

Methods: We conducted a mixed-methods pilot feasibility study in two Pacific Northwest primary care clinics caring for underserved populations. Clinicians were invited to participate in educational sessions on skin cancer screening and dermoscopy device use. Qualitative interviews with participating clinicians assessed training experiences. Outcomes measured intervention feasibility, knowledge scores, use of dermatology e-consults, referrals and biopsy rates.

Results: Clinicians exposed to the training (n=15) had significant gains in overall knowledge, with primary improvement in lesion identification and biopsy literacy. Referrals for in-person dermatology evaluation significantly decreased for the training-exposed clinicians (16.9 vs. 11.4 per 1000 visits pre, post respectively) whereas the comparison group (n=29) had a small increase (13.8 vs. 14.0 per 1000 visits). General skin check referrals decreased for the exposed group and increased for the comparison group, (p<0.01). Lesion-specific e-consults increased more in the intervention group but did not reach significance (p=0.05). Biopsy rates did not differ significantly. Qualitative findings highlighted training utility, especially image identification review and dermoscopy use.

Conclusions: Melanoma education increased the specificity of primary care clinicians' e-consults without increasing in-person dermatology referrals or unnecessary biopsies. While this intervention has promise for improving skin cancer care in primary care, efforts are needed to increase clinician engagement in this education.

Keywords: Access to Care, Biopsy, Dermatology, Dermoscopy, eConsult, Melanoma, Primary Health Care, Qualitative Research, Referral, Skin Cancer

Introduction

Cutaneous melanoma (CM) causes the majority of skin cancer-related deaths.^{1,2} In 2025, the American Cancer Society (ACS) projects that there will be 104,960 new cases of invasive melanoma and 8,430 deaths.^{2,3} While, immunotherapy has improved 5-year survival for stage IV melanoma to approximately 35%, early detection is critical, as the 5-year-survival rate for stage I disease exceeds 99%.² Despite the importance of early detection, access to dermatologists in

the United States (U.S.) remains poor and is the lowest for individuals of low socioeconomic status.⁴⁻⁶ Skin cancer education for primary care clinicians can address this gap; foundational knowledge empowers these primary care clinicians to triage and coordinate care for patients with possible skin cancers.

Most ambulatory care visits in U.S. are in primary care.⁷ Over 60% of patients with melanoma had a primary care visit within a year of diagnosis, compared to only 20% who had a dermatology visit.⁸ Moreover, primary care clinicians

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practice in a wide range of geographic regions, including underserved and rural areas, the latter of which have a higher incidence of melanoma and a lower number of dermatologists.⁹ Family medicine clinicians, in particular, possess the procedural skills to facilitate early skin cancer detection. There are, however, barriers to identification and management of skin cancers in primary care, which include limited dermatology training and confidence, time constraints, and limited workflows to prompt routine skin cancer examinations and support documentation.¹⁰⁻¹⁴

We designed a multifaceted educational intervention (MelaNOma) to improve primary care clinicians' knowledge and confidence identifying and triaging melanoma and using electronic health record (EHR) tools to support documentation.^{12,13,15} MelaNOma was tailored for busy clinicians and included education on skin cancer identification and risk, dermoscopy (a specialized technique that uses polarized light and magnification to visualize deeper skin structures), and EHR tools to assist with risk stratification, patient education, and clinician documentation.^{12,13,15,16} Our pilot study's primary outcome was testing the feasibility and acceptability of MelaNOma. We assessed clinician acceptance of the intervention through qualitative analysis. Secondary outcomes included the impact on clinician knowledge, rates of in-person dermatology referrals, e-consults to dermatology (a provider-to-provider electronic communication where the clinician submits diagnosis or management questions directly to dermatology and relays the recommendations to the patient), EHR tool use, and biopsies.

Methods

Study design

This study used a quasi-experimental, mixed methods design to test the feasibility, acceptability and utility of the MelaNOma intervention. Clinicians who were exposed to the intervention were compared to non-participants. This study was approved by the Oregon Health & Science University Institutional Review Board.

Setting

Two family medicine clinics affiliated with a Pacific Northwest hospital system participated; one urban federal qualified health clinic (FQHC) and one rural health clinic (RHC) were selected to represent variation in location and patient population.

Sample and Recruitment

Forty-five clinicians (physicians, physicians assistants, and nurse practitioners) received an email inviting them to participate in the MelaNOma training. In the RHC, we invited 12 clinicians from two of the clinic's teams via email, 6 (50%) participated. Teams were selected based on ability of clinicians to attend the training as those clinicians were scheduled to be present on the day of the intervention. At the FQHC, all 33 active clinicians in the clinic received an

email invitation, and 11 (30%) participated. The 17 clinicians who attended the first 40-minute training session were included in the exposure group. A total of 37 clinicians who were not invited or chose not to participate in the MelaNOma training session were assigned to the comparator group. Two of the intervention participants and 14 of the non-exposed group were excluded from analysis as they had less than 3 months of EMR data for the evaluation period. Analyses requiring complete EHR data included 15 in the exposed group and 29 clinicians in the comparator group, respectively (Figure 1).

MelaNOma Intervention

MelaNOma included a 40-minute hybrid training co-led by a family medicine physician and a dermatologist. The initial training drew content from the Melanoma Early Detection Toolkit (MTED)¹⁶ and focused on risk stratification, melanoma identification, and recommended biopsy techniques. Education also included a review of EHR tools, how to request an e-consult, and demonstration of a smart phone dermoscopy device, which clinics received to enhance skin lesion photography. The dermoscopy device used retails for \$100-200. Clinicians could participate in two optional "booster" trainings. The first booster was restricted to clinicians who attended the initial training session and was a series of five case-based emails, which included melanoma identification questions paired with knowledge questions called "snackables." The second was a hybrid 40-minute session that revisited key features of melanoma identification and provided practice with dermatoscopes. The second hands-on training was intended as a booster for those who attended the initial training, but clinicians who wanted to learn about lesion identification were not turned away. As such, some attendees at that session were in the comparator clinician group. Table 1 details the purpose and mode of the training. Figure 2 shows the training timeline. The MelaNOma education interventions were delivered in April and June 2023, followed by booster trainings four months later.

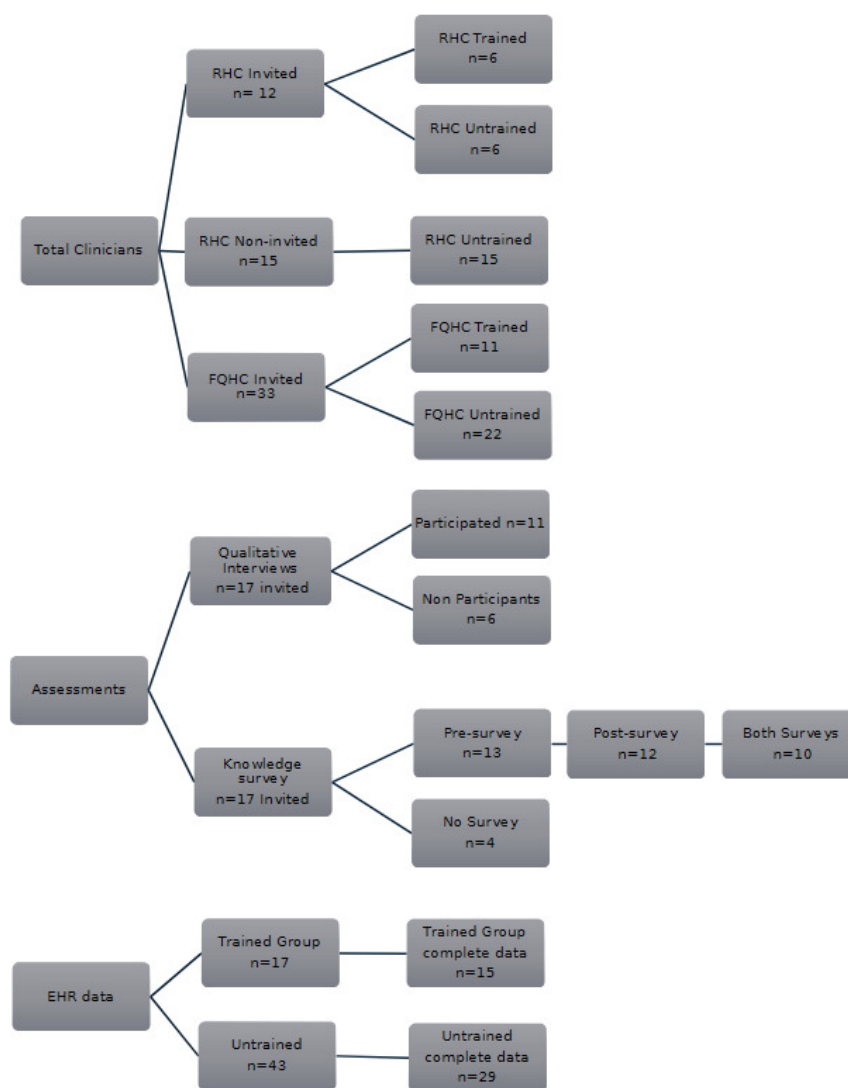
Notes: Timeline of MelaNOma training sessions and data collection. The pre- and post- knowledge assessments were administered up to 1 week prior to the initial MelaNOma training and immediately after the training, respectively. Those who attended the primary MelaNOma training were classified as the exposed to the education. Qualitative data was collected after all training sessions occurred. Quantitative data was collected for a 3-month period starting after the initial MelaNOma training.

Measures

Table 2 summarizes the study measures and data sources. We measured pre- and post- intervention rates of dermatology referral, dermatology e-consult, EHR tool use, use of medical photography for a skin-related issue, and biopsies performed using visit-level EHR data for all adults seen at the clinics during the study period.

Knowledge assessments were conducted using a web-based survey up to one week before and immediately after

Figure 1. MelaNOma Participant Flowsheet.



Notes: A flowsheet of participant training and data collection. Those who participated in MelaNOma Intervention were trained. Two participants from the trained group and fourteen participants from the control group were excluded due to insufficient number of months of practice for EHR analysis. Abbreviations: Electronic Health Record (EHR), Federally Qualified Health Center (FQHC), Rural Health Clinic (RHC)

the initial training (Appendix 1). We adapted 17 lesion identification and biopsy procedure knowledge items from the literature.^{16,17} Content relevant measures did not exist; we developed six questions to assess knowledge of melanoma risk and 4 questions on EHR tools specific to the training. A total score and 3 sub-scores (melanoma risk, EHR tools, and lesion identification) were generated then transformed to represent the percent of correct items (i.e., 0-100%).

Data Collection

Data extracted from the clinics' EHR, surveys and semi-structured interviews were collected between February 2022 and December 2023 (Figure 2).

EHR Data Collection

The initial training at each site was used to denote a pre- and a post-training period. Clinicians were required to have at least 3 months pre- and post-training data to contribute to the analyses. To control for seasonal influence on skin cancer diagnosis, we matched the calendar months of the post-training EHR data with the corresponding months in the previous year for each clinician.

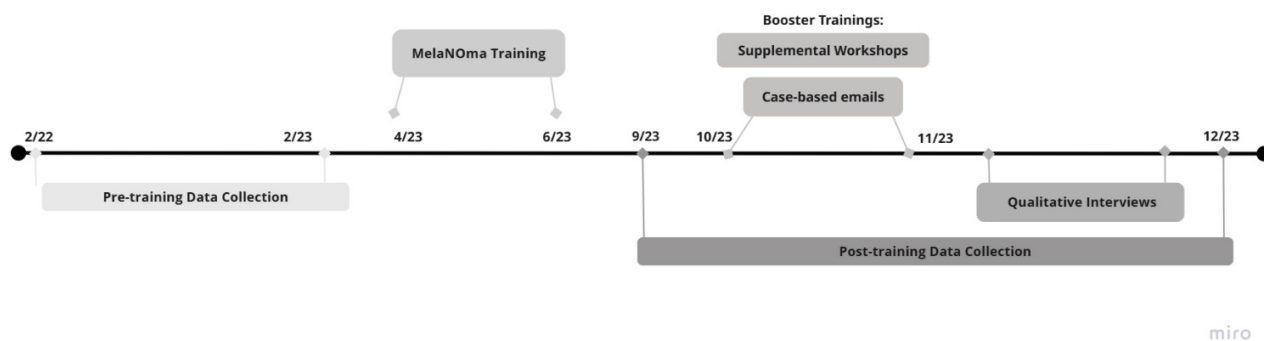
To examine if teaching about and providing a dermatoscope increased use of dermatology-specific medical photography documentation, we analyzed data for the presence of a medical photo *and* biopsy, dermatology referral, dermatology e-consult, or dermatology-related visit diagnosis. To evaluate accuracy of this abstraction approach, we conducted manual chart reviews of a 10% sample (n=188) of those photos; 60/65 (92%) were correctly identified as der-

Table 1. Components of the MelaNOma Educational Intervention.

Training	Program Purpose	Content/ Learning Objectives	Mode of delivery
Primary Training Session: Enhancing Skin Cancer Early Detection and Treatment in Primary Care	Improve the screening and identification of melanoma and how to diagnose and triage in primary care Improve the use of existing systems of care to enhance skin cancer care	<ul style="list-style-type: none"> Identify normal versus abnormal lesions Recognize patients with elevated skin cancer risk Practice hands-on smart phone dermatoscope use Demonstrate how to take photos with EHR Describe preferential biopsy techniques Discuss the different ways patients can receive skin cancer care outside of the traditional referral system 	Live in-person; virtual
Booster Training: Case-based “Snackable” via E-mail	Deliver small bite-sized case-based questions with information to reinforce learnings and promote application in practice	<ul style="list-style-type: none"> Identify normal versus abnormal lesions Review melanoma risk factors Identify workflows for suspicious lesions 	Weekly emails with a quiz question, 5 emails in total.
Second Live Training: Dermoscopy Skill Booster	Build further skills for identification, dermatoscope and EHR tool use	<ul style="list-style-type: none"> Review of abnormal lesion characteristics Practice hands-on photography and dermoscopy Illustrate how primary care doctors and dermatologists visualize and triage skin lesions 	Live in-person; virtual

Abbreviation: Electronic Health Record (EHR).

Figure 2. MelaNOma Study Intervention and Data Collection Timeline.



matology-related and 9/123 (7%) were not dermatology-related using the rubric. We deemed the accuracy acceptable for this study.

Two clinicians (Family Medicine and Dermatology) independently reviewed all pathology reports during the study period to categorize biopsy results as lesion-specific or inflammatory/rash. Malignant lesions were further stratified into melanoma, basal cell carcinoma, squamous cell carcinoma or other. All dysplastic nevi were categorized as benign. Re-excisions of malignancies were excluded. Discrepancies in coding were resolved through discussion.

Knowledge Survey Data Collection

Participants attending the MelaNOma training session were sent an email prompting them to complete pre- and post-test knowledge surveys. Non-respondents received a follow-up email.

Qualitative Interviews

Semi-structured interviews with clinicians exposed to MelaNOma were conducted several weeks after completion of all trainings. We developed and tested an interview guide (Appendix 2). Questions were selected to inform whether

Table 2. MelaNOma Study Measures, Variables and Data Sources.

Variable/ Definition	Data Source	Data Collection / Analysis
Compare changes in knowledge		
Clinician Knowledge - Clinicians' knowledge of risks, lesion identification and management of melanoma	Assessed via survey using 27 items. 17 lesion identification and biopsy items are drawn from prior study. The study team wrote the remaining 10 items.	Clinicians completed a web survey prior to and after the first training session. Surveys are matched by unique study identifier such that an individual change score can be computed. An overall knowledge score (all 27 items), Risk Assessment Knowledge (6 items), Knowledge of EHR tools (4 items) and Lesion Identification & Biopsy (17 items). Items are scored correct or incorrect and the score for total and subscores are represented as percent correct, ranging from 0-100%.
Compare changes in process of skin cancer assessment, referral and documentation		
Dermatology assessment - use of screening tool	Electronic Health Record (EHR) data abstracted through manual and automated methods	Operationalized at the clinician level representing the number per 1000 patients. Indicators are measured pre- and post-training.
Dermatology e-consult , reason for e-Consult		
Documentation - Use of Dot phrase*		
Dermatology referral , reason for referral		
Use of Medical photography for dermatology - binary variable indicating whether medical photography image was made.		
Compare Changes in Number of Melanomas Identified by Biopsy		
Number of biopsies and biopsy findings - counts and rates per 1000 patients indicating average biopsies per clinician and biopsy findings number of biopsies per 1000 patients	EHR data abstracted through manual and automated methods	Operationalized at the clinician level.
Assess the feasibility, appropriateness and acceptability of Melanoma Training		
Acceptability - Extent to which the training is agreeable, palatable, satisfactory	Assessed via semi-structured interview.	Qualitative Interviews with clinicians exposed to the training
Appropriateness - Extent to which the training fits and is compatible for addressing issue or problem		
Feasibility - Extent to which the training can be successfully used or carried out		

* AVS-After visit summaries: SKINCANCERAVS - adult, SKINCANCERAVSPEDS - pediatrics; Skin cancer physical exam phrase SKIN-CANCERPE. Biopsy phrases: SKINCANCERPUNCHBX and SKINCANCERSHAVEBXS. Screening tool: SKINCASCREEN.

the training was feasible and if it spoke to the aims of the intervention. Interviews, led by a qualitative researcher, were conducted via video or telephone, lasted 30-60 minutes, and were professionally transcribed, de-identified and checked for accuracy. We used Atlas.ti (version 9.0) for data management and analysis.

Analyses

We used descriptive analyses to examine participating clinician characteristics and rates of e-consults, dermatology referrals and biopsies performed (reported as cases per 1000 patients). We conducted a paired t-test to evaluate change in knowledge scores and used generalized estimating equa-

tion-based (GEE) models with link function of Poisson distribution and an exchangeable correlation structure to compare referral outcomes. The models included exposure to training (Yes/No), pre- and post-training time periods and the interaction of these two indicators as predictors. Analyses were two-sided, statistical significance was set at type I error of 5% and analyses were conducted using R Statistical Software.¹⁸

We analyzed qualitative data using an inductive approach to understand clinicians' experiences with MelanNOma. Transcribed interviews were tagged to identify emerging findings. Codes were defined and developed into a codebook. When definitions were clear and consistent we transitioned to independent analysis, with the group meet-

Table 3. Participant Characteristics.

	Total n=44	Training exposure n=15	No Training exposure n=29
Characteristics			
Sex, female	28 (63.6%)	10 (66.7%)	18 (62.1%)
Degree			
MD/DO	37 (84.1%)	10 (66.7%)	27 (93.1%)
PA/NP	7 (15.9%)	5 (33.3%)	2 (6.9%)
Resident (vs attending)	11 (25.0%)	0 (0.0%)	11 (37.9%)
Rural site (vs urban FQHC)	27 (61.4%)	10 (66.7%)	17 (58.6%)

Abbreviation: Federal Qualified Health Clinic (FQHC)

Table 4. Clinician Knowledge of Skin Cancer Risk, Identification & Biopsy.

Survey Content	Pre-Training Survey N=16	Post-Training Survey N=12	Pre-Post Change N=10	P
Total Score (27 items/survey)	72.1 (7.2)	80.8 (9.6)	8.1 (9.1)	0.02
Risk Assessment Knowledge (6 items)	66.7 (18.3)	79.2 (12.6)	11.7 (20.9)	0.11
Knowledge of EHR tools (4 items)	68.8 (22.7)	66.7 (24.6)	-3.3 (29.2)	0.73
Lesion Identification & Biopsy (17 items)	74.6 (10.7)	83.8 (11.3)	8.8 (12.5)	0.05

Abbreviation: Electronic Health Record (EHR)

ing to discuss findings. We conducted a series of comparative analyses to examine how participants' years in practice, credentials, and training modality (online versus in person) affected experience with the training, its benefits, including confidence identifying lesions, biopsy practices, use of the dermatoscope and dermatology consults.

Results

The clinicians that participated in the training had a slight female predominance (10/15, 66.7%) similar to the 62.1% (18/29) of the clinicians in the comparison group (Table 3). Participants were more likely to have NP/PA credentials (33.3% vs. 10.3%) and less likely to be a resident trainee (0% vs 37.9%) than the comparison group. Ten (67%) of the participants completed the pre- and post-training knowledge survey. Eleven (73%) participated in a qualitative interview (Figure 1).

Improvement of Clinicians' Knowledge and Experience with Training

Participants' overall knowledge scores significantly improved pre- to post-training (Table 4). Lesion identification and biopsy knowledge improved the most and increased from 74.6% to 83.8%. Knowledge of skin cancer risk assessment and EHR support tools did not demonstrate statistically significant improvement.

Results from the knowledge survey align with qualitative findings. Clinicians reported that image review and treatment discussions were most useful, as these portions of the training included new information about atypical forms of melanoma.

I remember that we looked at a lot of images, and some of the images were melanomas that don't fit a typical melanoma picture. That was helpful. To see some of the other presentations of melanomas outside of the really typical melanoma presentation that you'd see in a textbook or that's really obvious. (Rural Health Center (RHC), Participant 9)

Clinicians who attended the 40-minute training and reviewed the booster case-based emails found them to be an efficient use of time and reinforcing melanoma recognition.

I think the ability to test your own knowledge with immediate feedback [was helpful]. When you have different images and limited patient stories, it's exactly the amount of time, attention span and style that I needed for these reminders versus an hour-long session that I think I probably would've gotten more out of if I were in-person, but the self-paced quick questions and really testing myself, I think, was more helpful. (RHC, Participant 6)

Clinicians reported that the training did not change how they assessed risk, including the expanded risk factors that were identified in training, and few recalled the training about the EHR tools. The patient education handout (.SKINCANCERAVS) was the only EHR tool used by participants. Use was infrequent; use increased in both groups, but a greater increase for the clinicians exposed to the intervention ($p<0.01$). There was no difference between the groups in use of medical photography for dermatology-related issues. (Table 5).

Table 5. Rate of Referrals, e-Consults and EHR Tool Use at Baseline and Post-MelaNOma Training for Clinics 1 & 2 by Training Exposure Group*.

	Training Exposure		No Exposure		Group by time interaction
	Baseline (N = 15)	Post-Training (N = 15)	Baseline (N = 29)	Post-Training (N = 29)	P-Value
Total Number of Visits	7972	7339	9888	10432	
Dermatology Referral	16.9	11.4	13.8	14.1	0.02
Reason for Referral					
Biopsy proven skin cancer that needs surgery	0.1	0.1	0.0	0.2	<.01
Concern for skin cancer	3.1	3.5	2.9	2.7	0.57
Routine skin check	4.8	2.1	2.5	4.6	<.01
Skin lesion not cancer concern	1.2	0.7	1.1	1.1	0.39
Other	6.7	5.0	5.4	5.6	0.04
Unknown	1.1	0.0	1.9	0.0	0.99
Dermatology e-Consult	5.5	7.8	5.1	7.2	0.50
Lesion (evaluate for skin cancer)	1.6	4.8	0.9	2.1	0.05
Atypical Skin Ulcer/Wound	0.3	0.5	0.6	0.1	0.46
Inflammatory Skin Rashes	0.0	0.1	1.5	0.6	<.01
Unknown	1.2	0.3	1.0	1.5	0.06
Dot phrases					
SKINCANCERAVS**	0.0	0.7	0.0	0.3	0.01
Medical photography (photo taken during primary care clinician visit)					
All photographs (any)	33.6	36.7	47.1	55.8	0.99
Photographs specific to skin lesion concern	10.8	11.9	8.8	11.9	0.84

Notes: *All rates are calculated based on per 1000 patients. **SKINCANCERAVS: Skin cancer after visit summary. Abbreviation: Electronic Health Record (EHR).

Dermoscopy Device and Lesion Identification Training

Clinicians who attended in-person appreciated that dermoscopy devices were available, and they found the guided practice beneficial.

Everyone could practice putting it [the dermatoscope] on their phone. [...] That felt really helpful. You could use an oil that the thing comes with, or you could just use some hand sanitizer to put on the patient's skin. Then apply the device to that. They talked about taking a picture up close and taking a regular picture with your phone as well, not using the device, so you had both the birds-eye view and the super-magnified view. Then looking at your own skin or someone else's skin for practice to see how it worked and how to take a picture. (RHC, Participant 5)

Referrals and E-Consults

Referrals for in-person dermatology evaluation (Table 5) significantly decreased for the trained group (16.9 vs 11.4 per 1000 patient visits pre, post respectively) whereas the comparison group had a small increase (13.8 vs. 14 per 1000 patient visits pre, post respectively). Referrals for routine

skin checks decreased for the training-exposed group and increased for the comparison group, ($p < 0.01$). The trained group showed a trend towards increased referrals for concern for skin cancer and decreased referrals for benign lesions and other skin concerns (e.g. acne, rashes, and itching). This difference was not significant.

E-consults increased in both groups (Table 5). Lesion-specific e-consults increased more in the trained group but did not reach statistical significance ($p=0.05$). Clinicians reported using e-consults, prior to training, for non-cancerous dermatology complaints, but reported using e-consults more for suspected malignant lesions following training.

Training helped clinicians learn about the information and photos dermatologists need, which supported clinicians in confirming their differential diagnosis, and resulted in more actionable advice from the consult:

I learned why [dermatologists are] asking the questions that they are. I learned about how they want their photos taken and why, and so both those things were really helpful for me. Since then, I've gotten much more helpful E-consults from there. [...] [Before] I didn't have dermoscopic pictures, so frequently they were like, it needs to be evaluated in the dermatology clinic, and that was like 95 percent of the e-consults that I got

Table 6. Clinician Biopsy Rates (N = 44).*

	Training Exposure		No Exposure		Group × time interaction P-Value **
	Baseline (N = 15)	Post-Training (N = 15)	Baseline (N = 29)	Post-Training (N = 29)	
Number of Biopsies	4.197	4.712	1.853	3.65	0.391
Biopsy finding					
Lesion-specific					
Benign lesions	3.353	4.175	1.335	3.573	0.286
Malignant lesions	3.353	3.746	1.113	2.847	0.303
Melanoma	0	0.429	0.222	0.726	N/A
SCC	0	0.109	0	0	N/A
BCC	0	0.32	0.128	0.498	N/A
Other skin cancers	0	0	0.053	0.088	N/A
Rashes / Inflammatory	0	0	0.041	0	N/A
Rashes / Inflammatory	0.844	0.537	0.519	0.077	0.094

Notes: *All rates are calculated based on per 1000 patients. **P values with N/A indicate where models were not run due to small counts or models did not converge.

Abbreviations: BCC- Basal Cell Carcinoma, SCC- Squamous Cell Carcinoma

back...Now, they're like, "That's concerning for a basal cell, take it off." (RHC, Participant 7)

Education emphasized that e-consults could "fast track" patients to a dermatologist. In interviews, clinicians reported that suspicious lesions could require a six-month wait. Gaining faster access to dermatologist was a factor that motivated use of e-consults: "I did learn that if there is a diagnosis of melanoma, that there's a fast track to get people in [to Dermatology]..." (RHC, Participant 2).

Biopsies

During the study period, 124 biopsies were performed by 24 study clinicians. A larger proportion of the trained clinicians performed biopsies at baseline and following the educational intervention (pre: 9/15, 60.0%; post:10/15, 66.7%) vs. the comparison group (pre: 10/29, 34.5%; post:11/29, 37.9%). One melanoma was identified by a clinician in the trained group during the post-training period. Overall, there was no significant interaction effect of training group for the performance of biopsies (Table 6).

Clinicians reported in interviews that the biopsy training component increased their confidence and knowledge about these procedures. Particularly beneficial was information about biopsy types and circumstances for use, impact of biopsies on staging, and guidance on suturing. Clinicians at the RHC found this training particularly important as their patients can be reluctant to travel to a dermatologist.

Incorporation of Skin Examination into Practice

While clinicians found the MelaNOma training useful and reported using the dermoscopy device and e-consults more effectively, we do not know if training changed how and when they performed skin checks. We do know that skin examinations were not a routine part of visits.

I used to always do that as part of my exam during well-woman exams, but then they took off breast cancer screening as part of that exam, so I oftentimes don't make patients get into a gown... I will usually just ask patients if they have anything on their skin that's changed or that they would like me to take a look at. (RHC, Participant 5)

Time pressures affected clinicians' ability to prioritize skin checks. Clinicians report that skin checks were not tied to performance metrics like other preventive exams, and the training did not cover how to "logistically do skin checks" routinely (RHC, Participant 7).

Discussion

Our mixed methods feasibility study of the MelaNOma intervention shows that educating primary care clinicians can be a powerful approach for addressing access barriers to skin cancer care. The MelaNOma intervention increased clinician knowledge and lesion-specific dermatology e-consults without increasing in-person referrals or significantly increasing unnecessary biopsies. A recent review of primary care skin cancer education interventions identified four training components that successfully promoted practice change: interactive curriculum, web-based materials, significant primary care clinician involvement in curriculum design, and guidance on skin cancer management.¹² Our intervention contained all 4 components. Further, the curriculum sought to meet the educational needs of busy clinicians through supplementary, asynchronous training and an optional hands-on dermoscopy workshop that reinforced learning objectives. Although attendance was low, education was well-received and study participants appreciated the dermoscopy devices provided.

Few studies use qualitative methods to understand primary care skin cancer education interventions.¹⁹ Our interviews fill an important gap by providing insight into which training components were perceived as helpful and high-

lighting barriers to incorporation of skin examinations and biopsies into clinical practice. Clinicians cited the visual diagnosis and biopsy technique components of the training as the most useful, education on skin cancer risk stratification and EHR tools as not helpful, and they noted lack of reimbursement and time as persistent barriers to implementation of risk stratified skin cancer screenings. Lack of EMR tool adoption may also reflect that this was minor training component and not reinforced enough to change workflows. This suggests that institutional and systems-wide buy-in may be necessary to achieve practice change and promote wider adoption among clinicians.

Overall, this study has 29 important implications. First, optimizing e-consult use may allow for more sophisticated suspicious lesion triage and provide real-time feedback to the referring clinician. Although e-consult usage has steadily increased in recent years (accelerated by the COVID-19 pandemic), our study showed a much larger, but not statistically significant, increase in lesion-specific e-consult use among trained clinicians.²⁰ Approaches like the MelaNOma intervention that increase appropriate e-consults have the potential to facilitate more rapid skin cancer care, particularly when dermoscopic images are included.²¹⁻²⁴ For example, at our institution, a patient with an e-consult concerning for melanoma receives an appointment within 7 days compared to current in-person visit wait times of 6-12 months.

Second, the impact of the training on in-person referrals shows promise for improving referral quality. MelaNOma trained clinicians placed significantly fewer in-person referrals post-training compared to those who were not trained. This decrease was primarily driven by reductions in referrals for routine skin examinations and non-cancerous growths, which may indicate a decrease in sending low-risk individuals to specialists. Improving referral quality is critical in the over-burdened healthcare system where access to dermatologists is poor and wait times are long.

Our study joins other successful educational interventions that have shown a decrease in in-person dermatology referrals, specifically for benign lesions and low-risk individuals.²⁵⁻³⁰ Our multi-faceted MelaNOma educational curriculum built on lessons learned from the well-studied INternet course FOR Melanoma Early Detection (INFORMED) by augmenting our online asynchronous curriculum (MTED) with in-person sessions, case-based email boosters, and a dermoscopy introduction. Additional studies are needed to confirm the utility of these education components in broader primary care settings.

An important aspect of our intervention was providing clinicians with a dermoscopy device and training. Qualitative findings revealed that the training on lesion identification and hands-on use of the device were valuable, and some reported incorporating use into practice. However, no differences were observed in medical photography use as both groups had small increases. We note that there was no restriction on who could use the devices and the clinical workflow barrier of locating the device may slow adoption. Measuring use of dermoscopic from standard clinical photos is challenging and labor intensive as both are cat-

egorized as “medical photography” in the EMR. In the future, AI image sorting may provide a more precise measure of dermoscopy use.

Our study has additional limitations. While this study was designed to inform the feasibility and signals of effectiveness (gain in knowledge, shifts in referral behavior) at two family medicine clinic sites, the overall evaluation is limited by low participation (only 17/45 invited clinicians) and relatively short follow-up period to see practice change. The short follow-up also limited the evaluation of the impact of the training on skin cancer biopsies, which were a rare occurrence in this study. Further, clinicians that served as comparators were drawn from the same clinics as those that engaged in the MelaNOma intervention. This was deemed a strength but also risked the potential of passive knowledge transfer and sharing of the dermoscopy devices with comparator clinicians. Overall, a larger study size, clinic-level randomization to training exposure groups and more follow-up time is needed to more fully assess the impact of the training on clinician skin cancer identification and use of biopsy.

Conclusion

This study found that MelaNOma was a feasible educational intervention that increased clinician knowledge and lesion-specific dermatology e-consults without increasing in-person dermatology referrals or unnecessary biopsies. Additional refinement in content and implementation to support greater uptake of skin cancer detection and management is needed and should be the focus of future work.

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Conflicts of Interest and Disclosure

The authors have no conflicts of interest to declare. SKLIP dermoscopy devices were purchased for this study.

Peer Review

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Supplementary Materials

Appendix 1a. Knowledge Pre-Assessment.

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Appendix 1b. Knowledge Pre-Assessment.

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Appendix 2. Qualitative Interview Guide.

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